THE USE OF PERVASIVE TECHNOLOGIES IN BUSINESS PROCESSES

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Abstract: Innovative pervasive technologies are ubiquitous, integrated into the environment, and their main task is data collection. In the current era of widespread business process digitalization, the volume of data that needs to be collected, sorted, analysed and evaluated for the most accurate management decisions is continuously increasing. The article focuses on the area of digital production and its fundamentals, which include data, data acquisition sensors, the Internet of Things and information systems. Based on the analysis of the current state of use of individual innovative pervasive technologies in enterprises in the Slovak Republic, we point out the differences in their use among Slovak enterprises.

Keywords: data, innovative pervasive technologies, sensors, digitalization, digital production

1 Introduction

The emergence of innovative pervasive technologies has prompted the requirements of Industry 4.0 and they, on the other hand, contribute to its development. Innovative pervasive technologies and the Internet network, which triggered an industrial revolution in society, are becoming hyper-aware systems, featuring highly flexible technologies, following clear algorithms, responding not only to human commands but also to their own perception and guidance. In literature, when it comes to integrating innovative technologies into business processes, we encounter the concepts of data collection and analysis, new ubiquitous technologies, sophisticated sensors, robotics, cloud computing, Internet of Things, digital manufacturing, autonomy, systems interoperability, digitalization, virtualization, artificial intelligence, augmented reality, surrounding intelligence. Implementation of these technologies in business processes creates a new environment, which we call the ambient intelligence of a company.

New innovative technologies change individual business processes and areas. Kagermann (2014) introduce four key technologies, Industry 4.0 components, which include cyber systems (connections between the real and virtual world), the Internet of Things, the Internet of services and smart products, machine to machine (M2M) communication. M2M communication and smart products are not considered independent parts. M2M is the activator of the Internet of Things and smart products are a part of cyber-physical systems.

The article focuses on the digitalization of production and its fundamentals, which include data, data acquisition sensors, the Internet of Things and information systems. The conceptual apparatus is covered by definitions of domestic and foreign authors. The main objective is to analyse the current status of use of selected innovative pervasive technologies in enterprises in the Slovak Republic and to identify differences in their use among Slovak enterprises.

2 Literature Review

In the last decade, individual areas of production have been considered a highly developing area of IT. The digitalization of production is one of the main strategies of the European production vision and the strategic agenda towards knowledge-based production. It is driven by the application and standardization of information and communication technologies and increasing demand for operational efficiency in global networks (Westkämper, 2007).

The production environment is turbulent and requires continuous adaptation of production systems. Production engineering covers a wide range from networks to processes and from real time to long-term operations. The tools of future engineering and production management are digital and distributed.

Chryssolouris et al. (2009) point out the integration of information and communication technologies in production, which can significantly reduce production time, reduce costs, reduce product development costs, improve product quality and accelerate market response.

Digitalization of production cannot do without information technologies, data collection, data analysis, simulations, virtual reality, process automation and ultimately, e-commerce.

The introduction of three-dimensional printers and direct digital production brings a new paradigm, direct digital production (Chen et al., 2015) with a significant impact on society. Direct sustainability aspects of digital production are closely related to social, economic and environmental dimensions. Direct digital production combines the benefits of other production paradigms and has a positive impact on sustainable development, however a number of technical and societal challenges need to be addressed. Currently its incorporation into new types of assembly lines can already be observed and a high level of specification is becoming the norm.

Significant social aspects of digital production include lifestyle changes, changes in the labour market, working environment, waste management and others. Integration of information and communication technologies, virtualization and development of ambient intelligence bring about the formation of various paradigms, subdomains also in the area of digital production.

Important digital production fundamental items include data, data acquisition sensors, the Internet of Things, innovative pervasive technologies and information systems.

The volume of processed digital data doubles every 2 years (analogy to Moore's hardware law) (Grantz and Reinsel, 2012). The growth of digital data is not everything; at the same time, changes in the type of these data can also be observed.

The types of data processed can be divided into 3 main groups (Tyagi, 2012), namely structured data, semi-structured data and non-structured data. There is no exact definition of big data. There are many definitions in scientific publications by domestic and foreign authors, each of which is correct, but with a focus on a different aspect.

The importance of digital data is also increasing from an economic and social perspective. In 2015 the value of data in the European Union economy was over € 285 billion, which represents more than 1.94% of the EU's GDP. In 2016 the year-to-year growth of 5.03% of the data value increased their value to € 300 billion, representing 1.99% of the EU's GDP.

If EU countries and businesses operating in it support investment in ICTs, favourable political and legislative conditions will be created, and the European Commission estimates that the value of the European data economy could increase to € 739 billion by 2020, which is 4% of the total GDP of the European Union.

The increasing volume of these digital data creates volumes that exceed the capacities of conventional database systems. Hurwitz et al. (2013) defines big data as a combination of old and new technology that allows large amounts of data to be processed at a reasonable rate to provide the desired analyses at a given moment. Ohlhorst (2012) provides a more versatile definition -

"big data is such an extremely large data set that traditional data processing is insufficient for the required analysis." The concept of big data was more comprehensively defined by Dumbill (2012): "they are data whose processing exceeds the capabilities of conventional database systems. These data are too large, they move too fast, or their structure does not correspond to the existing database architecture. To acquire a value from such a data file, you need to choose an alternative method of processing."

Gartner analyst Doug Laney (2001) operates in a research study with the term big data complementing it with the 3V dimension. He names the term big data as a set of data whose size is beyond the ability to capture, manage and process data with commonly used software tools within a reasonable time, not only in terms of data volume but comprehensively in a three-dimensional context naming it as 3V (Volume - expresses an exponentially increasing amount of data within the relevant business area, Variety - information varies in countless types, resources, formats, structures, coding, syntax, etc., Velocity - the speed at which data are generated and the need for their real-time analysis) .

In his study, Kaptein (2018) points out how to consider new data categories and big data, such as "future data" and the role of uncertainty in designing a new generation of ambient intelligence. Ambient intelligence in terms of digital data needs:

- data that describe the current state of the world for devices operating in it;
- data processing, either through explicit human coded rules or more implicitly, machine-learned relationships;
- estimates of activity results.

The technologies that make up the Internet of Things must be designed with respect to economic demands versus technological demands. The portfolio of devices that enter the Internet of Things can be divided into the following three categories according to the way devices communicate with the application: passive, active and managed.

Passive - this group includes sensors operating on the principle of code (EAN, QR code), or RFID chip. From a physical point of view, an RFID small microchip is connected to an antenna, often in the form of a sticker. Scientific and technological advances have also brought semi-passive RFID, which are battery-powered. Information from these devices is read through a scanner, a reader. Their mass use in industry can be observed in particular in logistics.

Active - most sensors that communicate in only one direction are called active devices. They are a source of data that can be sent continuously or at the user's request. These are mostly various motion, door sensors, sensors, meters, cameras. In all these cases, the direction of communication from the device to the application is the priority.

Managed - these are devices that, in addition to collecting data and sending data based on an algorithm, can receive a managed instruction. These include lighting, thermo heads, security cameras (positioning, sharpening), sound equipment and many other. Such a device sends data to a controlling application. This can then change the behaviour of the device based on a program or user requirements.

Data from special sensors or other devices are sent over the Internet to the service provider. These data are then normalised in the IoT I/O interface module. Thus, the data of the various devices are adopted in a uniform format so that they can be stored in a database. Normalisation depends on the type of connected devices and the scope of services offered.

3 Methodology and data

The data that formed the basis for the statistical detection in order to determine the current situation in enterprises in the Slovak Republic and verification of the research hypothesis were obtained by a questionnaire survey conducted by occasional sampling in the period of 09/2018 - 06/2019 in enterprises in the Slovak Republic. Individual questions and variables were formulated based on induction, deduction and some degree of abstraction. The questionnaire (complying with the conditions of validity and reliability) contained open, closed questions, which were measured by nominal, ordinal and interval variables. The Likert scale of 0 - insignificant to 6 - very significant influence was applied. When confronting our conclusions, we also used secondary statistical data.

The object of the investigation were enterprises in the Slovak Republic. The relevant respondents whose responses were included in the analysis were 206. The survey structure consisted of 79% of commercial enterprises, 6% of self-employed persons and 15% of other enterprises. The representativeness of the sample was ensured by regional equilibrium, while the sample was from all regions of Slovakia. The structure of the sample by sectors approximates the distribution of enterprises in the national economy (statistical classification of economic activities - SK NACE).

The biggest share belonged to enterprises from industrial production (24%), other activities (13%) and wholesale and retail (12%). We segmented enterprises by size (table 1) based on the European Commission's Recommendation 2003/361/EC, based on the number of employees (micro 1-9, small 10-49, medium 50-249, large enterprise >= 250).

Table 1: Survey sample structure

Enterprise size	Number
Micro	17.48%
Small	19.42%
Medium	24.76%
Large	38.35%
Total	100.00%

Source: Authors' own research

We use an extensive set of mathematical-statistical methods to evaluate the data obtained by a questionnaire survey. We measure the accuracy and dependability of this research tool through reliability - Cronbach Alpha - because the items the questionnaire is made of are not dichotomous, but have a larger range (Likert scale). We analysed the reliability of the scales used. The reliability of the scale of individual platforms examined is $\alpha = 0.843$. Field and Hole (2010) report that a Cronbach alpha level above 0.8 is an acceptable level, a lower value means a relatively unreliable scale. The author Anýžová (2015) works with the value of Cronbach's alpha at the level of 0.7, which she denotes as the lower confidence limit.

In the research results, we analysed whether companies differ in their use of innovative pervasive technologies depending on their size. A hypothesis was set for the purpose of exact investigation:

H_0: Enterprises depending on their size (micro, small, medium, large) do not differ significantly in the use of individual innovative pervasive technologies.
H_1: Enterprises, depending on size (micro, small, medium, large), differ significantly in the use of individual innovative pervasive technologies.

In the individual analytical parts we used descriptive statistics to analyse the current state of integration of these pervasive technologies. We verified the assumption of normal data distribution using the Kolgomor-Smirn test. Since the conditions for normal data distribution were not met, we used the non-parametric Kruskal-Wallis test. Among the variables, we also examined dependence using the eta coefficient.

4 Results

To streamline business processes, it is necessary to capture data from individual processes that take place in the enterprise. These data are transformed into repositories, then processed by appropriate methods, resulting in decision-making data, and thus affecting production, operational and business processes. The core environment is the Internet, which allows you to transmit information inside, within the enterprise and with the outside world. In manufacturing enterprises, it is usually difficult to connect devices directly to the Internet, so several technologies are used to transfer data that need to be interconnected. Ultimately, the data obtained from these devices need to be distributed over the Internet, transformed into an information system, and provide appropriate inputs/outputs for individual downstream processes.

In this section, we analyse the current state of use and the intention of enterprises to implement selected technologies that serve for data collection.

Table 2: Implementation of data collection

Data collection	Micro	Small	Medium	Large	∑
we do not carry out	11.11%	15.00%	1.96%	3.80%	6.80%
we carry out internally	72.22%	70.00%	90.20%	83.54%	80.58%
we carry out externally	16.67%	15.00%	7.84%	12.66%	12.62%
∑	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Authors' own research

Each enterprise generates data that is a valuable resource for business management decision making. The results specified in Table 2 report that 81% of enterprises collect data internally, 13% externally. Internally, data are primarily collected by medium and large enterprises. Micro and small enterprises use external form of data collection, or some of them do not collect these data at all.

Internal data collection is favoured more by manufacturing companies - 84% of manufacturing enterprises, 10% external data collection and 6% do not carry out data collection. The external form of data collection is more favoured by non-manufacturing enterprises 15%, compared to manufacturing companies 10%. Non-manufacturing enterprises (78%) use internal data collection and 7% of non-manufacturing enterprises do not collect data.

Table 3: Data collection via RFID

Enterprise status/size	Micro	Small	Medium	Large	∑
Cannot be carried out	61.11%	70.00%	35.29%	35.44%	46.60%
We only know theoretically	27.78%	20.00%	33.33%	11.39%	21.36%
We have considered, but we do not carry out yet	2.78%	0.00%	19.61%	11.39%	9.71%
We will carry out	8.33%	0.00%	3.92%	5.06%	4.37%
We have already taken the first steps	0.00%	2.50%	1.96%	5.06%	2.91%
We are gradually implementing	0.00%	2.50%	0.00%	12.66%	5.34%
Implemented	0.00%	5.00%	5.88%	18.99%	9.71%
∑	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Authors' own research

Several technologies can be used for data collection. RFID is one of them. The level of use by enterprises (Table 3) is very low M = 1.50, SD = 2.01, up to 78% of enterprises do not use this technology, 13% plan to implement it and only 10% of enterprises already have this technology. The RFID technology is present the most in large enterprises in terms of size. Micro and small enterprise have encountered this technology only to a very small extent and are not even considering its implementation. The structure within manufacturing/non-manufacturing enterprises is very similar. 90% of manufacturing and 92% of non-manufacturing enterprises do not use RFID, 5% of manufacturing and 8% of non-manufacturing are planning to implement RFID. Only 5% of manufacturing enterprises use the RFID technology.

Table 4: Data collection by means of barcodes

Enterprise status/size	Micro	Small	Medium	Large	∑
Cannot be carried out	55.56%	55.00%	35.29%	22.78%	37.86%
We only know theoretically	13.89%	12.50%	11.76%	7.59%	10.68%
We have considered, but we do not carry out yet	5.56%	2.50%	5.88%	6.33%	5.34%
We will carry out	5.56%	0.00%	5.88%	2.53%	3.40%
We have already taken the first steps	5.56%	5.00%	3.92%	2.53%	3.88%
We are gradually implementing	5.56%	5.00%	5.88%	7.59%	6.31%
Implemented	8.33%	20.00%	31.37%	50.63%	32.52%
∑	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Authors' own research

Data collection can also be carried out using barcodes, EAN codes. This technology is used by enterprises (Table 4) at the level of M = 2.74, SD = 2.66, 54% of enterprises do not use it, 14% plan to implement it and 33% of enterprises have this technology. Compared to previous the RFID technology, the use of barcodes, or planned use, also occurs with smaller businesses. It is mainly used by large and medium-sized enterprises, manufacturing enterprises 20%, while 10% enterprises plan to implement it. In the case of non-manufacturing enterprises, it is used only by 8% and 17% would be interested in using it.

Table 6: Data collection carried out by means of QR codes

Enterprise status/size	Micro	Small	Medium	Large	∑
Cannot be carried out	50.00%	55.00%	45.10%	25.32%	40.29%
We only know theoretically	25.00%	22.50%	15.69%	10.13%	16.50%
We have considered, but we do not carry out yet	19.44%	2.50%	13.73%	13.92%	12.62%
We will carry out	2.78%	2.50%	7.84%	2.53%	3.88%
We have already taken the first steps	0.00%	5.00%	5.88%	12.66%	7.28%
We are gradually implementing	0.00%	0.00%	5.88%	13.92%	6.80%
Implemented	2.78%	12.50%	5.88%	21.52%	12.62%
∑	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Authors' own research

A technologically higher level of data collection is provided by QR codes. Their use in enterprises (Table 5) is at the level of M = 1.92, SD = 2.18, this form of data collection is carried out only by 13% of them, while 18% of enterprises plan to implement them. QR codes are used by large businesses (22%). Micro, medium and small enterprise are mostly aware of this technology only on a theoretical level, but are considering introducing it. This technology is mainly used by 13% of manufacturing enterprises and 8% plan to introduce it. With non-manufacturing enterprises, only 3% use QR codes to collect data and 3% plan to use QR codes for data collection.

Table 6: Data collection carried out by means of sensors

Enterprise status/size	Micro	Small	Medium	Large	∑
Cannot be carried out	52.78%	47.50%	23.53%	20.25%	32.04%
We only know theoretically	5.56%	10.00%	3.92%	5.06%	5.83%
We have considered, but we do not carry out yet	16.67%	7.50%	7.84%	3.80%	7.77%

We will carry out	8.33%	2.50%	11.76%	1.27%	5.34%
We have already taken the first steps	5.56%	5.00%	7.84%	8.86%	7.28%
We are gradually implementing	2.78%	10.00%	19.61%	8.86%	10.68%
Implemented	8.33%	17.50%	25.49%	51.90%	31.07%
∑	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Authors' own research

Based on the results of the analysis, it can be concluded that companies especially use various sensors for data collection (Table 6) at the level of M = 3.06, SD = 2.55, which is closely determined by the nature of the business. This technology is used by 31% of enterprises, 23% of enterprises plan to implement and use them in data collection, and 46% do not use this technology. The use of these technologies is predominantly present in large (52%) and medium enterprises (26%), but is gradually being introduced in small enterprises as well. Sensors are especially used by manufacturing enterprises, 18% of them are already fully collecting data from these technologies, 18% plan to implement these technologies. In case of non-manufacturing enterprises, only 8% of them use sensors in data collection and 17% of enterprises plan to introduce them.

The following part presents the results of the survey focused on the transformation of the acquired data into an information system. In business practice, it often happens that enterprises collect data but do not transform it into an information system for further analysis and evaluation.

Table 7: Transformation of acquired data into information system

Enterprise status/size	Micro	Small	Medium	Large	∑
Cannot be carried out	11.11%	5.00%	3.92%	2.53%	4.85%
We only know theoretically	11.11%	5.00%	1.96%	2.53%	4.37%
We have considered, but we do not carry out yet	19.44%	0.00%	3.92%	1.27%	4.85%
We will carry out	5.56%	10.00%	9.80%	2.53%	6.31%
We have already taken the first steps	2.78%	10.00%	5.88%	2.53%	4.85%
We are gradually implementing	5.56%	17.50%	11.76%	10.13%	11.17%
Implemented	44.44%	52.50%	62.75%	78.48%	63.59%
∑	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Authors' own research

We positively evaluate the level of transformation of the obtained data into an information system (Table 7), which reaches the value of M = 4.90, SD = 1.81. Up to 61% of businesses transform the collected data into an information system for the purpose of a deeper analysis. In 22% of enterprises, their management considers the idea of introducing a data transformation process into their information system in order to streamline processes and decision making. However, there is still a certain percentage of enterprises (14%) that passively collect data but do not transform it into an information system. Relatively satisfactory values are achieved by all four sizes of enterprises, transformation into the information system is most often carried out by large enterprises (79%), medium enterprises (63%), small enterprises (53%) and micro enterprises (44%).

Transformation of data into an information system is not carried out in inverted sequence by micro enterprises (11%), small enterprises (5%), medium enterprises (4%) and large enterprises (3%). In particular, manufacturing enterprises (53%) transform the collected data into an information system, while 38% of manufacturing enterprises are considering implementing these processes. Non-manufacturing enterprises (44%) carry out the transformation of collected data into the information system, 14% of them consider introducing this transformation and 42% do not and will not carry out the transformation of data into an information system in the near future.

Table 8: Manual import of data into information system

Enterprise status/size	Micro	Small	Medium	Large	∑
Cannot be carried out	2.78%	25.00%	5.88%	21.52%	15.05%
We only know theoretically	2.78%	0.00%	7.84%	7.59%	5.34%
We have considered, but we do not carry out yet	11.11%	2.50%	1.96%	1.27%	3.40%
We will carry out	5.56%	2.50%	3.92%	0.00%	2.43%
We have already taken the first steps	22.22%	5.00%	9.80%	2.53%	8.25%
We are gradually implementing	13.89%	12.50%	11.76%	5.06%	9.71%
Implemented	41.67%	52.50%	58.82%	62.03%	55.83%
∑	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Authors' own research

The level of data collection and its subsequent manual import into an information system (Table 8) is M = 4.36, SD = 2.30, 24% of enterprises do not manually import the collected data into an information system, 20% of enterprises deal with the idea of their manual import into their information system. Manual data import (56%) is used in particular by large and medium-sized enterprises. It is necessary for these enterprises to move towards full automation.

Similarly, 20% of non-manufacturing enterprises and 29% of manufacturing enterprises do not collect data with manual import into an information system, with 24% of non-manufacturing enterprises and 14% of manufacturing enterprises consider the idea of introducing this form of import. Up to 55% of non-manufacturing enterprises manually import data into an information system, in case of manufacturing enterprises it is 57%.

Table 9: Automatic data import into an information system

Enterprise status/size	Micro	Small	Medium	Large	∑
Cannot be carried out	19.44%	30.00%	7.84%	2.53%	12.14%
We only know theoretically	13.89%	5.00%	5.88%	0.00%	4.85%
We have considered, but we do not carry out yet	25.00%	10.00%	9.80%	7.59%	11.65%
We will carry out	8.33%	5.00%	11.76%	2.53%	6.31%
We have already taken the first steps	11.11%	5.00%	3.92%	1.27%	4.37%
We are gradually implementing	5.56%	22.50%	21.57%	24.05%	19.90%
Implemented	16.67%	22.50%	39.22%	62.03%	40.78%
∑	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Authors' own research

When building ambient intelligence, integrating innovative pervasive technologies, it is necessary to move data collection and import into an information system to the level of full automation. This method is for the analysed enterprises (Table 9) at the level of M = 4.09, SD = 2.18, 29% of enterprises do not carry out automated data collection and its import into an information system, 31% of enterprises would like to implement this method and 41% of enterprises already use this form. Meanwhile, enterprises prefer to use the manual form of data collection and import to automatic, although in terms of percentage the differences are not too big. Automatic data collection is used primarily by large enterprises, up to 62% of them. Only 2.5% of large enterprises do not carry out this collection and do not even consider this form in the near future. Automated data collection is largely not carried out by micro and small enterprises.

Communication is important not only between individual information systems, but also technologies that provide for data collection. The following section analyses the communication of devices within an enterprise.

Table 10: Interactive communication between technologies and information systems using NFC

Enterprise status/size	Micro	Small	Medium	Large	∑
Cannot be carried out	55.56%	55.00%	33.33%	34.18%	41.75%
We only know theoretically	13.89%	22.50%	29.41%	15.19%	19.90%
We have considered, but we do not carry out yet	8.33%	2.50%	9.80%	12.66%	9.22%
We will carry out	5.56%	0.00%	3.92%	10.13%	5.83%
We have already taken the first steps	8.33%	0.00%	3.92%	5.06%	4.37%
We are gradually implementing	5.56%	7.50%	5.88%	3.80%	5.34%
Implemented	2.78%	12.50%	13.73%	18.99%	13.59%
∑	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Authors' own research

The use of the NFC technology (Table 10), which represents a short-range, high-frequency, contactless connection allowing data exchange between devices, is at the level of M = 1.82, SD = 2.18, of which it is at the lowest level of all the analysed technologies. Only 14% of enterprises use this technology, while 16% of enterprises consider its implementation. The NFC technology is most represented in large enterprises (19%), medium enterprises (14%) and small enterprises (13%). The NFC technology is used mainly by manufacturing enterprises (13%), non-manufacturing enterprises (3%) for communication between devices. However, as many as 19% of non-manufacturing enterprises are considering implementing it, while only 8% of manufacturing enterprises would like to implement this technology. The most important reason for the low penetration of the use of this technology is the short-range connection.

Table 11: Interactive communication between technologies and information systems using WIFI

Enterprise status/size	Micro	Small	Medium	Large	∑
Cannot be carried out	36.11%	30.00%	23.53%	17.72%	24.76%
We only know theoretically	5.56%	2.50%	5.88%	7.59%	5.83%
We have considered, but we do not carry out yet	8.33%	2.50%	7.84%	5.06%	5.83%
We will carry out	8.33%	0.00%	7.84%	3.80%	4.85%
We have already taken the first steps	2.78%	7.50%	3.92%	5.06%	4.85%
We are gradually implementing	13.89%	7.50%	17.65%	8.86%	11.65%
Implemented	25.00%	50.00%	33.33%	51.90%	42.23%
∑	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Authors' own research

Enterprises primarily use WIFI technology to communicate between devices (Table 11). The use of this technology is at the level of M = 3.63, SD = 2.54, the technology provides much wider use than the NFC technology. This technology is used by 42% of enterprises for communication between devices (production, sensors, etc.), 21% of enterprises are considering using it and 36% of enterprises do not use this technology yet. Communication between devices via WIFI technology reflects the percentage of usage associated with WIFI coverage. Enterprises that collect data through various technologies (sensors, codes, etc.) and have WIFI coverage of the entire enterprise also use this technology to communicate between these technologies. The communication of devices via WIFI is secured mainly with manufacturing enterprise (50%), 15% of companies would like to use this technology in communication with devices. With non-manufacturing enterprises, 25% of enterprises use WIFI technology for communication between devices and 25% plan to use this technology for communication between individual devices.

Table 12: Interactive communication between technologies and information systems using Bluetooth

Enterprise status/size	Micro	Small	Medium	Large	∑
Cannot be carried out	50.00%	52.50%	43.14%	36.71%	43.69%
We only know theoretically	25.00%	15.00%	9.80%	20.25%	17.48%
We have considered, but we do not carry out yet	11.11%	5.00%	13.73%	6.33%	8.74%
We will carry out	2.78%	2.50%	3.92%	5.06%	3.88%
We have already taken the first steps	0.00%	5.00%	1.96%	1.27%	1.94%
We are gradually implementing	2.78%	0.00%	13.73%	5.06%	5.83%
Implemented	8.33%	20.00%	13.73%	25.32%	18.45%
∑	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Authors' own research

Another alternative that can be provided between devices (manufacturing, sensors, etc.) in an enterprise is the use of Bluetooth technology (Table 12). The utilisation by analysed enterprises is at the level of M = 1.94, SD = 2.35. Bluetooth is used only by 18% of enterprises, 12% consider introducing it. Bluetooth is most represented with large enterprises (25%) and then small enterprises (20%). This technology is particularly used by manufacturing enterprises (20%), 8% of enterprises plan to implement this technology. Non-manufacturing enterprises use Bluetooth to a very limited extent, with only 8% of enterprises, 6% plan to implement the technology, and 86% do not use this technology at all.

In relation to the analyses of the data collection and communication platforms used we analysed the use of the Internet of Things. We also examined individual areas of use of this platform.

Based on the analyses, we can observe that the Internet of Things penetration is the highest in the area of data processing 73%, communication 68% and information security 68%.

For a more detailed analysis, we chose the area of the collection of data that are subsequently processed and form the basis for decision making.

We verified the assumption of normal data distribution using the Kolgomor-Smirn test. Data were not normally distributed RFID $p < 0.000$, EAN $p < 0.000$, QR $p < 0.000$ and sensors $p < 0.000$. Since the conditions for normal data distribution were not met, we used the non-parametric Kruskal-Wallis test.

Based on the results of the statistical analysis, we conclude that companies differ statistically significantly in the use of individual RFID tools (M = 1.51, SD = 2.01) $\chi2(3) = 27.437$; $p < 0.000$, EAN (M = 2.74, SD = 2.66) $\chi2(3) = 26.735$; $p < 0.000$, QR (M = 1.92, SD = 2.18) $\chi2(3) = 26.081$; $p < 0.000$, sensors (M = 3.06, SD = 2.55) $\chi2(3) = 32.554$; $p < 0.000$, depending on the size of the enterprise.

We reject H_0 hypothesis and accept H_1 hypothesis: Enterprises, depending on size (micro, small, medium, large), differ significantly in the use of individual innovative pervasive technologies.

Based on the results of statistical testing we conclude that the size of an enterprise has a significant impact on the use of innovative pervasive technologies, sensors intended for data collection in the enterprise.

Among the variables, we also examined dependence using the eta coefficient. After statistical testing, we concluded that up to 15.76% of RFID technology use is affected by the size of an enterprise ($\eta = 0.397$, i.e. a moderate correlation coefficient). 12.74% of the effect of using EAN codes is influenced by the size of the enterprise ($\eta = 0.357$, moderate dependence). 14.82% of the effect of using QR codes is influenced by the size of the enterprise ($\eta = 0.385$, which is also a moderate correlation coefficient). In the case of sensors ($\eta = 0.399$, it is also a moderate, substantial dependence) up to 15.92% of their use is influenced by the size of the enterprise.

5 Discussion

Data and information are currently one of the enterprise's most valuable resources. Data and information transforms business across multiple segments, enabling companies to achieve success, identify new opportunities, and solve problems they were previously unable to resolve. When looking for a meaningful boundary between data volume and relevancy, the basic prerequisite for working with them is the understanding of what business users really need. In accordance with our findings, we identify with the statements of the authors (Geissbauer, Vedsø and Scharauf, 2016; Mesaros, 2016; Stuchlý and Látečková, 2017; Maulen, 2017; Kaptain, 2018), who consider data and data analytics as an important element of ambient intelligence.

Data collection and the Internet of Things are closely related. It is currently estimated that about 8 billion devices are connected to the Internet, which together make up the Internet of Things. When estimating the number of devices connected to the Internet in 2020, various sources differ significantly. In August 2016, IEEE published an article (Nordrum, 2016) with findings where the estimated number of devices is supposed to reach 50 billion. Based on this forecast, the number of these devices should increase six times from the current number in the course of next 2 years. A slightly more pessimistic forecast was published in February 2017 by Gartner (Maulen, 2017). According to its forecast 20.5 billion devices will be connected to the web at the end of 2020. Along with them, the volume of data transmitted over the Internet will increase opening the continuum of the Internet of Things and big data.

Schwab and Davis (2018) in his book Shaping the Fourth Industrial Revolution claims that "unlike previous industrial revolutions, the digital content expansion of new technologies evolves at an exponential rather than a linear pace..." Innovative pervasive technologies can shorten delivery times, increase the usability of means, maximize the quality of products and services. Their application and utilisation is broad regardless of industry or business activity.

6 Conclusion

Businesses entities should accept ongoing changes and adapt to economic conditions. Each enterprise should therefore set an individual strategy for success, which should reflect continuous changes in the economic environment as well as technological development.
Ambient intelligence, among other things, integrates sensor technology with information systems that are capable of collecting and evaluating data in order to prevent errors and maintain product quality. It is important to mention that data analysis does not only concern production processes, but all areas of economic and social life. Currently, it can be used to identify new market gaps, opportunities, financial and insurance services, human resources, health and other areas of social and economic life. The challenge is to use the enterprise's analytical capabilities to monitor the ecological footprint and improve the enterprise's environmental performance.

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